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## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the liquid crystal display which devised the black matrix for the improvement in use efficiency of light, and its manufacture method with respect to a liquid crystal display and its manufacture method.

[0002]

[Description of the Prior Art] Conventionally, between each pixel of a liquid crystal display, the leakage light of a liquid crystal panel which prevents the incident light to TFT (thin-film-semiconductor element formed on the substrate) was prevented, and the metal shading film which consists of chromium, a chrome oxide, etc. for improving display nature etc. and which is usually called black matrix was formed.

[0003] Moreover, recently, the thing of the resin type which contains pigments, such as carbon, as this black matrix is also used increasingly.

[0004]

[Problem(s) to be Solved by the Invention] However, by the shading film of metals, such as chromium of about 60% of reflection factors, repeat reflection of the light from the reflecting plate of the maximum inner in a pixel, the light source on the back, etc. being again reflected in the direction of the inner in a pixel, and being further reflected in the direction of the screen (user) again from the reflective section of the maximum inner in a pixel will be made in many cases, and much light will be changed into heat in the meantime. As a result, the use efficiency of light is not good.

[0005] On the other hand, by the shading film of a resin, in order to absorb such light similarly, this and efficiency for light utilization do not improve.

[0006] By the way, although that is right especially in the liquid crystal display which used the basis of the correspondence to the request to highly-minute(pixel-density of responsibility is highly good)-izing of a picture in recent years, and TFT In the substrate in which the screen or a pixel is formed, the semiconductor device section has a big area. since [ for this reason, ] a numerical aperture {the value which broke the area of the viewing area (or pixel) of a pixel by the sum (area of the screen of a liquid crystal display) of the area of this and a black matrix} surely becomes small -- merely -- even coming out -- there is an inclination for the rate of the amount of the light which goes in the direction of those who look at the screen from a pixel to decrease For this reason, it is important to make the display of a pixel contribute efficiently the light which comes from the interior of a pixel to a black matrix.

[0007] Development of a black matrix which contributes to improvement in an optical utilization factor was desired by the above reason.

[0008]

[Means for Solving the Problem] It raises efficiency for light utilization by reflecting this reflected light in the direction of the screen of a pixel again by the reflecting plate of the maximum inner in a pixel etc., it reflecting completely the internal light from the reflecting plate of the maximum inner in a pixel, the light source on the back, etc. using the black matrix which has the cholesteric structure which does not have the absorption of light on the occasion of reflection, and making [ in view of the above technical problem, accomplish this invention, and ] an operation of a black matrix accomplish.

[0009] Moreover, in electrochromatic display display, selective reflection of the whole visible region is carried out, using a cholesteric type light filter in piles.

[0010] Moreover, incidence of the lighting light used for a display is carried out from the reflex action

exertion side side by the side of a black matrix, and the effect of selective reflection is enlarged.

[0011] Moreover, it is used as a spacer for holding a substrate interval uniformly, using a cholesteric type light filter in piles.

[0012] Specifically, it is considering as the following composition.

[0013] In invention according to claim 1, it is characterized by having the black matrix section which used the matter of cholesteric type structure as a black matrix between the pixels of a liquid crystal display.

[0014] The following operations are made by the above-mentioned composition.

[0015] Since it is the black matrix which consists of liquid crystal of the cholesteric type structure where it \*\*\*\*\* (ed) etc., reflecting in the pixel inside (anti-user side) efficiently etc. intercepts by carrying out the reflected light and a light source light in back from the inner in a pixel, such as being equal to a spiral pitch.

[0016] In invention according to claim 2, the black matrix section is characterized by being the reflected type black matrix in which internal light is reflected according to cholesteric type structure.

[0017] The following operations are made by the above-mentioned composition.

[0018] The black matrix section is using the liquid crystal of cholesteric type structure, and thereby, if it remains as it is, it reflects efficiently the internal light which does not go in the direction of those who look at the screen, but should be absorbed in the direction of the inner in a pixel.

[0019] In invention according to claim 3, the liquid crystal display is characterized by being the electrochromatic display display which used the light filter.

[0020] The following operations are made by the above-mentioned composition.

[0021] A liquid crystal display is the electrochromatic display display which used light filters, such as R, G, and B, for the pixel viewing area.

[0022] In invention according to claim 4, the light filter which exists in the pixel field which will give color to a pixel is characterized by being the cholesteric light filter which consists of matter which has cholesteric structure.

[0023] The following operations are made by the above-mentioned composition.

[0024] A light filter is a cholesteric light filter which has cholesteric structure, and, for this reason, the permselectivity and reflection nature of light are excellent.

[0025] In invention according to claim 5, the black matrix section between pixels is characterized by being the light-filter laminating black matrix which accumulated and formed the light filter which should originally be shown only in the viewing area of a pixel also in the position which should have a black matrix.

[0026] The following operations are made by the above-mentioned composition.

[0027] A black matrix is a light-filter laminating black matrix which extended and formed the light filter for two colors also few to the black matrix section, and was accumulated further.

[0028] In invention according to claim 6, the light filter is characterized by being the spacer combination formation light filter which thickens in piles the thing for colors which is different in the black matrix section in principle, and is used also [ spacer ].

[0029] The following operations are made by the above-mentioned composition.

[0030] The light filter is characterized by being the spacer combination formation light filter used as the spacer which holds uniformly substrate intervals, such as glass [ which carries out phase opposite of the different thing for colors on both sides of the liquid crystal layer of a pixel viewing area in piles / of two sheets ].

[0031] In invention according to claim 7, a liquid crystal display is a liquid crystal display equipped with the polarizing plate, and is characterized by having the phase contrast element which consists of matter which has cholesteric structure, or changes into the linearly polarized light the reflected light from the black matrix which uses the matter.

[0032] The following operations are made by the above-mentioned composition.

[0033] A liquid crystal display is a liquid crystal display of the type equipped with the polarizing plate, and a phase contrast element changes into the linearly polarized light the reflected light which carried

out the circular polarization of light from the black matrix section which has cholesteric structure so that it may not be absorbed by the polarizing plate.

[0034] In invention according to claim 8, the black matrix section is characterized by being the TFT array substrate side black matrix formed in the TFT [ which absorbs light ], and TFT array substrate side with wiring.

[0035] The following operations are made by the above-mentioned composition.

[0036] The black matrix section is a TFT array substrate side black matrix, and since it is formed on TFT etc., it reflects completely the light which should originally be absorbed by TFT etc. For this reason, the use efficiency of light improves depending on the type of liquid crystal equipment.

[0037] In invention according to claim 9, it is characterized by having the substrate side lighting incidence section which carries out incidence of the lighting toward an opposite substrate side from a substrate side with a black matrix.

[0038] The following operations are made by the above-mentioned composition.

[0039] It has the substrate side lighting incidence section, and, thereby, incidence of the lighting is carried out from a certain substrate side by the side of reflection of the good black matrix of reflective efficiency.

[0040] In invention according to claim 10, it is characterized by having the black matrix section cholesteric type structure reflecting plate formation step which forms the reflecting plate of the cholesteric type structure which used cholesteric type liquid crystal for the black matrix section.

[0041] The following operations are made by the above-mentioned composition.

[0042] At a black matrix section cholesteric type structure reflecting plate formation step, the reflecting plate of cholesteric type structure which reflects the light from the interior in the interior again is formed in the black matrix section.

[0043] In invention according to claim 11, as a light filter for color display, the complementary color is not only absorbed and it is characterized by having the cholesteric light-filter formation step which forms what has cholesteric structure.

[0044] The following operations are made by the above-mentioned composition.

[0045] What has the cholesteric structure of making light penetrating alternatively as a light filter, and reflecting other colored light at a cholesteric light-filter formation step is formed.

[0046] In invention according to claim 12, the cholesteric light-filter formal step is characterized by being the light-filter black matrix combination formation step which accumulates a light filter and forms a black matrix.

[0047] The following operations are made by the above-mentioned composition.

[0048] It is a cholesteric light-filter formal step, i.e., a light-filter black matrix combination formation step, and in case a light filter is formed, in order to accumulate this and to form a black matrix, the width of face of selective reflection spreads.

[0049] In invention according to claim 13, the cholesteric light-filter formation step is characterized by being the light-filter spacer combination formation step which forms a spacer for the different thing for colors in piles.

[0050] The following operations are made by the above-mentioned composition.

[0051] A cholesteric light-filter formation step is a light-filter spacer combination formation step, makes a thick film the thing for colors which is different by this in piles, and forms the spacer for holding two substrates intervals uniformly.

[0052]

[The gestalt of operation] Hereafter, this invention is explained based on the gestalt of the operation.

(Gestalt of the 1st operation) The gestalt of this operation adopts the matter of cholesteric structure as a black matrix. the principle of the exertion of the cross section of the liquid crystal display (panel) of the gestalt of this operation of an effect to (a) of drawing 1 is shown in (b) which is drawing 1

[0053] (a) of this view shows the display principle of the light and darkness of the liquid crystal display of the gestalt of this operation.

[0054] In this view, 1 is a lower (an anti-user side, screen side) substrate, the black matrix 5 and a light

filter 6 are formed in the upper part, and the polarizing plate 7 grade is formed in the lower part. 2 is a polarizing plate 7 and an up substrate in which TFT which is not illustrated in addition to this is formed. 4 is a liquid crystal layer between both [ these ] substrates. And these [ 1 and 2 ] are the original liquid crystal panels (the important section) 3.

[0055] Moreover, 11 is the light source prepared under this liquid crystal panel (earth side) etc. 12 is a light guide plate. 13 is the reflecting plate stuck and prepared in the tooth back (anti-user side) of a light guide plate.

[0056] In (a) of this view, a liquid crystal panel is caudad led with a light guide plate, and incidence of the light 20 which came out of the light source of the equipment lower part is carried out to the display which consists of the original display part slack pixel section and an original black matrix.

[0057] And in the Ming display, the light 21 of specific wavelength which passed the light filter passes the liquid crystal layer and up substrate from which the liquid crystal molecule is in the state of passing light, and, thereby, a pixel serves as a bright specific color. It is [ which it is absorbed in the liquid crystal layer which is in the state where, as for the light 22 of specific wavelength which passed the light filter on the other hand in the dark display, a liquid crystal molecule does not pass light ] sufficient, and it is made [ being absorbed with a polarizing plate, etc. and ], and it does not come out outside but, thereby, a pixel becomes dark with as. Therefore, it is the same as the thing of the conventional technology so far.

[0058] Next, this content is different although it is the operation of a black matrix which reflects in a back [ of a pixel ], and reflecting plate side the light which comes out of the light source and goes in the direction of the screen.

[0059] Hereafter, this content is explained, referring to drawing (b).

[0060] The black matrix of this liquid crystal panel is carrying out cholesteric structure, and has a spiral structure. For this reason, the good selective reflection 23 arises in the wavelength corresponding to the spiral pitch. However, since this light that selective reflection is carried out and goes to a light guide plate side is the circular polarization of light, if it remains as it is, or will be absorbed a little by the polarizing plate. Then, in order to prevent it, in the liquid crystal display of the gestalt of this operation, the phase contrast element 8 (usually 1/4 wavelength plate) which changes this circular polarization of light into the linearly polarized light is formed in the black matrix side of a polarizing plate.

[0061] For this reason, a polarizing plate is passed as it is, and a light guide plate side (lighting-system side) is reached again, it is re-reflected by the reflecting plate (a diffusion board may be used) of 24 and its tooth back, incidence of this light by which selective reflection was carried out is carried out into the pixel of the display of a liquid crystal panel once again, and it goes in the direction of those who are finally looking at this from the original viewing-area slack pixel section more often.

[0062] For this reason, conventionally, the light lost in the black matrix section will be reused, efficiency for light utilization improves, and the screen becomes bright.

[0063] Next, important sections, such as an operation of this black matrix itself and a principle, are explained.

[0064] The selective reflection of the light by cholesteric structure is explained first.

[0065] This is the phenomenon in which the liquid crystal of cholesteric structure reflects alternatively the circular polarization of light corresponding to the pitch of the spiral. In addition, the selective reflection by cholesteric structure is indicated in detail by JP,8-146416,A, JP,7-175079,A, JP,7-152029,A, etc., for example. For this reason, the explanation beyond this is omitted on these specifications.

[0066] Next, in order to carry out selective reflection of the whole light field as a black matrix, it is necessary to use the cholesteric structure where pitches differ. And the method of making the cholesteric structure of a pitch which piles up the cholesteric structure of a different pitch or is different in the film of one layer intermingled etc. is desirable. However, since this is also indicated by above-mentioned JP,8-146416,A etc., for example, the explanation beyond this is omitted on these specifications.

[0067] Moreover, there are some which fabricated what mixed foreign element liquid crystal in the polymer liquid crystal and liquid crystal oligomer polymer which consist of a cholesteric-liquid-crystal

phase as a material system to be used, and the transparent macromolecule, and the thing which mixed a polymer liquid crystal or liquid crystal oligomer to the transparent macromolecule to the shape of a film and the tabular. In addition, since these are also indicated by JP,8-146416,A, JP,5-61039,A, etc., the explanation beyond this is omitted.

[0068] Moreover, as the manufacture method, there is the method of fixing cholesteric structure according to photopolymerization after orientation processing using the thing of photoreaction nature as it is indicated by the method of performing orientation processing at the temperature more than a glass transition point, cooling at the temperature below a glass transition point, and fixing the structure or JP,6-230371,A as it is indicated by JP,5-61039,A, for example. However, since it is the technology known to some extent even if it does not reach common knowledge technology so to speak about these, the explanation is omitted.

[0069] Hereafter, the manufacture method of the liquid crystal display of the gestalt this operation is explained.

[0070] First, the black matrix was produced on the glass substrate.

[0071] In addition, the manufacture method of this black matrix is the same method as the example 1 shown in above-mentioned JP,8-146416,A using liquid crystal oligomer.

[0072] The laminating of the cholesteric-liquid-crystal film of three layers with which the produced selective reflection wavelength differs was carried out, and it patternized so that it might correspond to the wiring and the TFT section of a TFT array substrate which are another substrate by the dry etching method.

[0073] Moreover, the light filter was produced using the usual FOTORISO method on this.

[0074] The plan of the TFT substrate which counters (a) of drawing 2 in the manufactured light-filter substrate with a black matrix at (b) of drawing 2 is shown. In this view, 6 is each light filter of RGB, 5 is a black matrix, 31 is the TFT section, and 32 is the wiring section. In addition, the numerical aperture at this time was 50%.

[0075] And the liquid crystal panel was produced by the usual method using this substrate.

[0076] Moreover, the usual orientation processing and the usual spacer spraying were carried out using TN method.

[0077] In addition, the edge light for the lighting of this produced liquid crystal display is purchased from Fujitsu Chemicals. Moreover, a phase contrast board is 1/4 wavelength plate (phase contrast of 140nm).

[0078] Thus, the display was very bright when the produced liquid crystal display was turned on.

[0079] Moreover, in order to investigate the effect of the liquid crystal display of this invention in detail, the area of a black matrix was changed, the example of the light-filter substrate of various numerical apertures was produced, the liquid crystal display was similarly produced by the basis, and the luminosity was compared. Consequently, it turns out that it is effective, so that the numerical aperture was small.

[0080] In addition, in this case, the light source has been arranged so that a light filter may be passed from the inner in a pixel, the substrate in which TFT was formed further may also be passed and it may go to a user side.

(Example 1 of comparison) The liquid crystal display of various numerical apertures was produced using the chromium thin film usually used for a black matrix for comparison. And those luminosities were compared with the gestalt thing of the 1st operation. The result is shown in Table 1.

[0081]

[Table 1]

表1 本実施例および比較例の液晶パネルの開口率と明るさの関係

液晶パネル番号	開口率	実施例1の液晶表示装置の明るさ(nit)	比較例1の液晶表示装置の明るさ(nit)	明るさ向上効果(倍)
1	90%	288	270	1.07
2	80%	276	240	1.15
3	70%	264	210	1.26
4	60%	252	180	1.4
5	50%	240	150	1.6
6	40%	228	120	1.9
7	30%	216	90	2.4
8	20%	204	60	3.4
9	10%	192	30	6.4
9・(TFT側から照明)	10%	72	30	2.4

70% or less of numerical apertures to which the area of a black matrix [ as opposed to the pixel section in the effect with the improvement more remarkable than this table in a luminosity ] increases, as a result the rate of reflection by the black matrix increases -- being generated -- beginning -- 60% or less -- 1.5 or more times -- becoming -- 40% or less -- then -- about -- it turns out that it is 2 double not less [0082] Moreover, since it will be absorbed in TFT before light reaches a light filter and a black matrix if an up-and-down substrate is made reverse, it is a book.

(Gestalt of the 2nd operation) The gestalt of this operation uses cholesteric structure for a light filter.

[0083] In addition, although it is the formation of the light filter which has a specific property itself, this is the same method as the example of JP,9-304613,A, and, for this reason, omits explanation about this.

[0084] Hereafter, formation of a up to [ the substrate 10 for light filters of the light filter of the gestalt of this operation ] is explained, referring to drawing 3 .

[0085] (a) Appoint stripe-like the viewing areas 61, 62, and 63 and the black matrix field 5 where the long and slender band of R, G, and B was located in a line on the above-mentioned substrate. In addition, this black matrix field of setting also corresponding to TFT of an opposite substrate and wiring which are not illustrated is natural here.

[0086] (b) All over a substrate top, only red passes and other color light forms light-filter film 61a to reflect.

[0087] (c) In dry etching, leave a red viewing area and a red black matrix field, and remove this light-filter film.

[0088] (d) Carry out green chisel passage and other color light forms green light-filter film 62a to reflect on a substrate.

[0089] (e) Leave the green viewing area at dry etching, and a black matrix field, and remove this light-filter film.

[0090] (f) Similarly, carry out blue chisel passage, and other color light forms blue light-filter film 63a to reflect on a substrate, and leaves and removes the blue viewing area at dry etching, and a black matrix field still more nearly similarly.

[0091] By (f) of drawing 3 , partial 5a which the filter for red, green, and blue (RGB) colors piled up becomes a black matrix.

[0092] Now, as shown in (g) of this drawing 3 in this case, a black matrix will reflect the light 25 of all wavelength in a pixel \*\*\*\* inner efficiently.

[0093] Thus, the liquid crystal display was produced for the produced substrate like the gestalt of previous operation of the 1st combining the TFT substrate. And when the luminosity was measured, the very bright display was obtained similarly.

(Gestalt of the 3rd operation) The light-filter substrate with a black matrix which has the black matrix which piled up the light filter by the same method as the gestalt of previous operation of the 2nd was

produced. However, it changed to spraying of the usual glass spacer etc., and two substrates intervals whose liquid crystal layer is pinched for the superposition section of a light filter as it is were produced combining the TFT substrate as a spacer for keeping it constant.

[0094] At this time, thickness of a light filter was set to 2.5 micrometers, respectively. For this reason, the thickness of the black matrix section which piled up three layers is set to 7.5 micrometers, and since it is set to 5 micrometers between the crowning of this black matrix section, and the light-filter upper surface of the 1st layer, it serves as thickness usable as a spacer.

[0095] Subsequently, since pouring of the liquid crystal molecule to the pixel circles concerned became difficult for all the circumferences of the pixel section to be spacers, the injected hole (slitting section) of required \*\*\*\*\* was formed in the black matrix section.

[0096] Others produced TN liquid crystal panel by the same method as the gestalt of previous operation. Under the present circumstances, it is easy to form a film in a latus substrate thinly uniformly. for this reason, the high degree of accuracy of 5micrometer\*\*0.1micrometer in cell \*\* and quantity -- the uniform panel was obtained

[0097] After an appropriate time, the liquid crystal display was produced like the 1st of the point, and the gestalt of the 2nd operation. This is shown in drawing 4 .

[0098] In this view, it turns out that the two-layer light filter is bearing the role of the spacer for holding both the substrates interval uniformly between the black matrix of the upside TFT array substrate 2 and the upside lower part, and the light-filter formation substrate 1.

[0099] When the luminosity of this liquid crystal display was measured, it was very bright like the 1st of the point, and the gestalt of the 2nd operation. The gestalt of <BR> (gestalt of the 4th operation) book operation forms a black matrix on TFT by the side of a TFT array substrate, or the wiring section, as shown in drawing 5 .

[0100] Hereafter, this liquid crystal display is explained, referring to this view.

[0101] In this view, 2a is an up glass substrate in a user side, and the TFT array 30 is formed in the inferior surface of tongue. Moreover, 61, 62, and 63 are red, green, and a blue display Mr. pixel respectively, 4 is a liquid crystal layer, and 5 is the black matrix section. And the red and green which were manufactured by the matter which has cholesteric structure, and three light filters 61a, 62a, and 63a for blue are formed in the inferior surface of tongue of this black matrix section in piles, and black matrix 5a which has cholesteric structure by this is formed.

[0102] Moreover, 1a is a lower (anti-user side) glass substrate, 11a is the light source on the back, and 13 is a reflecting plate on the back. In addition, although it has the polarizing plate etc. above else, since there is no direct relation to the operation and effect concerning this invention of the liquid crystal display in the gestalt of this operation, these are not illustrated.

[0103] Now, since what should be absorbed by the TFT array originally formed in the up glass substrate among the light from the light source on the back is reflected in the reflecting plate which served as the black matrix in the case of the liquid crystal display shown in this view, it will not be absorbed. As a result, it will be reflected in users by the reflecting plate on the back, and the use efficiency of this light of light improves.

(Gestalt of the 5th operation) The gestalt of this operation forms in the reflecting layer of the substrate of the tooth back (anti-user side) of a scattered-about type liquid crystal display the reflecting layer which has cholesteric structure, as shown in drawing 6 .

[0104] Hereafter, this liquid crystal display is explained, referring to this view.

[0105] In this view, 2b is an up glass substrate. And the field is divided into the pixel section 60 and the black matrix section 5. It is a lower glass substrate, and the TFT array 30 is formed in the upper surface, three light filters 61a, 62a, and 63a which have red, green, and the cholesteric structure for blue are further formed in the upper surface in piles, and 1b forms the reflecting plate.

[0106] This scattered-about type liquid crystal display now, in the Ming display In order that a liquid crystal layer may reflect an extraneous light 26 irregularly, a part of extraneous light 28 goes to a user's eyes. in a dark display the extraneous light 27 reflected since a liquid crystal layer reflected regularly light from the source of an extraneous light with existing [ much ] in a user's upper part (reflection



according to Fermat's principle) -- a user goes caudad, all say that it does not go into the eye, and, thereby, the display of the light and darkness of a pixel is made

[0107] By the way, a reflection factor and directivity improve that it is the reflecting plate which has cholesteric structure in this case. Moreover, in order to form on a TFT array, disorder of the absorption of light by this and dispersion is not produced, either.

[0108] And the display excellent in contrast and lightness will be made by making by this the extraneous light to a tooth back reflected irregularly go to users again in the Ming display, and making an extraneous light reflect regularly in a dark display. In addition, a part of light filter is not formed for every pixel in this case, or it combines with this further, a color reflecting plate is prepared in a tooth back (lower part), a light filter is prepared in the upper part, and, of course, it can make it possible to accomplish color display.

[0109] As mentioned above, although this invention has been explained based on the gestalt of operation of the some, this invention of nothing being limited above is natural. That is, you may perform it as follows, for example.

[0110] 1) Although the array of the pixel of R, G, and B was made into the stripe for the facilities of pouring of a liquid crystal molecule in the case of color display, the mosaic etc. is considered as other arrays.

[0111] Furthermore, the suitable reflective absorption film is used together for every color.

[0112] 2) Liquid crystal layer thickness, the type of liquid crystal, the number of the polarizing plates according to this, etc. are suitably made into other types, the size, etc.

[0113]

[Effect of the Invention] As explained above, in this invention, the reuse to the recycling of light carried out [ being conventionally absorbed in the black matrix section etc. and ] or the Ming display was performed efficiently, consequently the bright (it is easy to be efficiency for light utilization) display was attained.

[0114] This effect is as large as the liquid crystal display using active matrices, such as TFT of which a numerical aperture surely tends to consist small under the correspondence to the demand of the formation of quantity thin energy of a picture especially.

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[Translation done.]